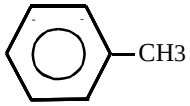
TOLUENE

Toluene is a federal hazardous air pollutant and was identified as a toxic air contaminant in April 1993 under AB 2728.

CAS Registry Number: 108-88-3

Molecular Formula: C_7H_8



Toluene is a colorless, flammable, non-corrosive liquid with a benzene-like odor. It is insoluble in water and soluble in acetone, absolute alcohol, ether, chloroform, benzene, petroleum ether, glacial acetic acid, and carbon disulfide (HSDB, 1991).

Physical Properties of Toluene

Synonyms: methacide; methylbenzene; methylbenzol; phenylmethane; toluol

Molecular Weight:	92.13
Boiling Point:	110.7 °C
Melting Point:	-95 °C
Flash Point:	40 °F (closed cup)
Vapor Density:	3.2 (air = 1)
Vapor Pressure:	36.7 mm Hg at 30 °C
Density/Specific Gravity:	0.866 at 20/4 °C (water = 1)
Log Octanol/Water Partition Coefficient:	2.69
Conversion Factor:	1 ppm = 3.77 mg/m^3

(HSDB, 1991; Merck, 1989; Sax, 1987; Sax, 1989; U.S. EPA, 1994a)

SOURCES AND EMISSIONS

A. Sources

Toluene is used in aviation gasoline and high-octane blending stock, and as a solvent for paints, coatings, gums and resins. Other sources include tobacco smoke, petroleum and coal production, use as a chemical intermediate, and for styrene production.

The primary stationary sources that have reported emissions of toluene in California are crude petroleum and natural gas extraction, petroleum refining, and household furniture

manufacturing facilities (ARB, 1997b). Toluene has also been detected but not quantified in motor vehicle exhaust by the Air Resources Board (ARB) (ARB, 1995e).

Toluene was registered for use as a pesticide; however, as of January 1, 1987, it is no longer registered for pesticidal use in California (DPR, 1996).

B. Emissions

The total emissions of toluene from stationary sources in California are estimated to be at least 5.4 million pounds per year, based on data reported under the Air Toxics "Hot Spots" Program (AB 2588) (ARB, 1997b). In addition, ARB staff estimates that 12.6 million and 62 thousand pounds per year are emitted from area and natural sources, respectively (ARB, 1990b).

C. Natural Occurrence

Natural sources of toluene include volcanos, forest fires, and crude oil (HSDB, 1991).

AMBIENT CONCENTRATIONS

Toluene is routinely monitored by the statewide ARB air toxics network. The network's mean concentration of toluene from January 1996 through December 1996 is estimated to be 8.29 micrograms per cubic meter ($\mu g/m^3$) or 2.2 parts per billion (ppb) (ARB 1997c).

The United States Environmental Protection Agency (U.S. EPA) has also reported concentrations of toluene from 14 study areas during 1989 to 1991. The overall mean concentration from these areas was 10.2 $\mu g/m^3$ (2.7 ppb) (U.S. EPA 1993a).

INDOOR SOURCES AND CONCENTRATIONS

Environmental tobacco smoke (ETS) emissions of toluene were measured using six cigarette brands popular in California and one reference cigarette. Toluene had an average emission of 656 μg/cigarette (Daisey et al., 1994).

There have been studies that have measured toluene within vehicles. A southern California study measured an average toluene in-vehicle concentration of 136.5 $\mu g/m^3$ (36.3 ppb) and a maximum concentration of 994.6 $\mu g/m^3$ (264.5 ppb) during the summer of 1987 and winter of 1988 (Shikiya et al., 1989). Similar studies in Raleigh, North Carolina and Boston, Massachusetts measured average concentrations of 33.3 and 46.5 $\mu g/m^3$ (8.9 and 12.4 ppb) and maximum concentrations of 105 and 118.9 $\mu g/m^3$ (27.9 and 31.6 ppb), respectively (Chan et al., 1991a; Chan et al., 1991b). These studies found toluene concentrations to be 2 to 5 times greater than outdoor toluene concentrations.

ATMOSPHERIC PERSISTENCE

Toluene exists in the atmosphere in the gas phase, and the dominant tropospheric loss process is by reaction with the OH radical. The calculated half-life and lifetime of toluene due to reaction with the OH radical are 1.7 days and 2.4 days, respectively (Atkinson, 1995). The reaction products include benzaldehyde, benzyl nitrate, cresols, glyoxal, methylglyoxal, and poorly understood ring-opened compounds (Atkinson, 1994).

AB 2588 RISK ASSESSMENT INFORMATION

The Office of Environmental Health Hazard Assessment reviews risk assessments submitted under the Air Toxics "Hot Spots" Program (AB 2588). Of the risk assessments reviewed as of December 1996, for non-cancer health effects, toluene contributed to the total hazard index in 51 of the approximately 89 risk assessments reporting a total chronic hazard index greater than 1. Toluene also contributed to a total hazard index greater than 1 in 7 of the approximately 107 risk assessments reporting a total acute hazard index greater than 1, and presented an individual hazard index greater than 1 in 1 of these risk assessments (OEHHA, 1996b).

HEALTH EFFECTS

The most probable route of human exposure to toluene is inhalation (HSDB, 1991).

Non-Cancer: Exposure to toluene may cause mild eye and respiratory tract irritation. The central nervous system (CNS) is the primary target organ for acute and chronic exposures. Toluene is a CNS depressant. Exposure may cause cardiac arrhythmias. Liver and kidney injury may occur with exposures to high concentrations. Long-term abuse by inhalation has caused CNS impairment (U.S. EPA, 1994a).

A chronic non-cancer Reference Exposure Level (REL) of 200 $\mu g/m^3$ is listed for toluene in the California Air Pollution Control Officers Association Air Toxics "Hot Spots" Program, Revised 1992 Risk Assessment Guidelines. The toxicological endpoints considered for chronic toxicity are the central or peripheral nervous system, and the reproductive system including teratogenic and developmental effects (CAPCOA, 1993). The U.S. EPA has established a Reference Concentration (RfC) of 400 $\mu g/m^3$ for toluene based on neurological effects in humans. The U.S. EPA estimates that inhalation of this concentration or less, over a lifetime, would not likely result in the occurrence of chronic non-cancer effects. The U.S. EPA has established an oral Reference Dose of 0.2 milligrams per kilogram per day based on changes in liver and kidney weights in rats. The U.S. EPA estimates that consumption of this dose or less, over a lifetime, would not likely result in the occurrence of chronic, non-cancer effects.

Children of pregnant women exposed to toluene by inhalation have been reported to have developmental effects, such as CNS dysfunction, attention deficits, and minor craniofacial and

limb anomalies; however, these studies were confounded by exposure to multiple chemicals. A number of case reports of toluene abuse via inhalation by pregnant women have also shown similar effects. Reproductive effects, including an association between paternal exposure to toluene and an increased odds ratio for spontaneous abortions but not birth defects, have also been noted. However, these studies are not conclusive due to many confounding variables. Several inhalation studies have shown toluene to be a developmental toxicant, but not a reproductive toxicant, in rodents (U.S. EPA, 1994a). The State of California under Proposition 65 has determined that toluene is a developmental toxicant (CCR, 1996).

Cancer: Two epidemiological studies did not detect a statistically significant increased risk of cancer due to inhalation exposure to toluene. However, these studies were limited due to the size of the study population and lack of historical monitoring data. The U.S. EPA has placed toluene in Group D: Not classifiable as a carcinogen (U.S. EPA, 1994a). The International Agency for Research on Cancer has placed toluene in Group 3: Not classifiable as a carcinogen (IARC, 1989b).